

Plenary Talks

Cardiac and Arterial Contribution to Blood Pressure

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Blood pressure and blood flow result from the interaction of the heart, the pump, and the arterial system, the load. We will discuss the function of the left heart and systemic arterial system alone and in relation to each other.

First, descriptions of the two subsystems will be given. Aortic pressure and flow make it possible to derive the input impedance of the arterial system. From the input impedance we learn how the arterial system functions. Two basic approaches can be used to describe the arterial load in quantitative terms, lumped models and transmission models. From the point of the load on the heart these descriptions are complementary in the sense that both are valid and that the choice should depend on the questions to be asked. From left ventricular pressure and volume or from left ventricular pressure and outflow two different descriptions of the heart as a pump can be obtained. These two descriptions are complementary and the two can be translated into each other. The central finding is that the heart is neither a pressure source nor a flow source. Again the choice depends on the questions to be asked.

Second, using these quantitative descriptions, we will show examples of the coupling of the heart and the arterial system. We show that the heart is matched to the arterial load in the sense that heart rate is coupled to the characteristic time of the arterial system and that the heart pumps at optimal power output. We will also show what happens in hypertension where the resistance of the peripheral vessels is increased, while cardiac output is hardly decreased. With the increased pressure, arterial stiffness is decreased, and the heart muscle hypertrophies thereby changing cardiac pump function. The heart begins to approach a flow source. Using the models derived above, we can calculate the individual contributions of the arterial load and of the heart to the blood pressure. We conclude that when the heart hypertrophies, as a result of the hypertension, the changed cardiac behavior, in turn, increases blood pressure even more. In failure the heart approaches a pressure source resulting in a decreased flow.

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